TITLE

HANDLING SYSTEM FOR DUAL SIDE INSPECTION

FIELD OF THE INVENTION

The invention is directed to automated systems for video inspection and, more particularly, to automated systems for optically inspecting for manufacturing defects on both sides of small components, such as closures or bottle caps that are manufactured at high speed.

BACKGROUND OF THE INVENTION

Various systems for optically inspecting closures are known in the prior art. When possible, inspection is accomplished during the manufacturing process thereby eliminating the need for additional handling or mechanics. Often, however, inspection during the manufacturing process is either impractical or compromises inspection performance. Thus, there remains a need to inspect components after the manufacturing process is complete. In such a situation, the components can be placed in secondary star-wheels or on conveyer belts to carry them through the inspection area. If inspection is required on both sides of the manufactured item then more elaborate handling is required. For example, a window placed beneath the star-wheel that carries the components across the inspection area can be used, but the window must be constructed in a fashion that permits viewing area to be resistant to damage - thus requiring specific damage-resistant material, which increases cost. Costs are also increased for maintaining such systems if the viewing area in such systems is damaged. Alternatively, more conventional handling processes, such as conveyor belts, can be used wherein the components are placed on a conveyor belt and are inspected on one side and then are inverted and placed in a similar handling system for inspection on the reverse side. There are problems with such systems, however. First, conveyor-type systems have many working parts that must be maintained regularly, which adds to operation cost. Further, if one or more of the working parts fail, the system may have to be shut down for repair. Still further, such systems take up a large amount of space.

Thus, there exists a need for a more aggressive automated handling system that permits high speed inspection, is compact, has less working parts, and is less expensive to operate and maintain.

SUMMARY OF THE INVENTION

The invention is a novel automated apparatus for optically inspecting both sides of manufactured components for manufacturing defects. The invention can be used to inspect either ferrous or non-ferrous components.

The components to be inspected are directed on to one of two rotable discs. Behind one of the rotable disks is a non-rotable magnet.

The ferrous components are held in place on the rotable disc by the magnetic force exerted upon the component by the nonrotable magnet. The components pass through an inspection station where one side of the component is inspected. The component is then transferred to the other rotable disc. The component, again, is held in place by the magnetic force exerted upon it from another nonrotable magnet which is positioned behind the rotable disc. If the component fails to meet the requirements of inspection, the invention rejects the component.

To inspect nonferrous components, apertures are provided instead of magnets to hold the components on the rotable disc. A vacuum plenum is placed behind the rotable discs and acts upon the components through the apertures to hold the components in place during inspection.

By possessing a pair of rotable discs that convey ferrous components through inspection areas and a pair of nonrotable magnets that alternately hold and release the ferrous components, it is an object of the present invention to provide an automated inspection system that permits high speed dual-sided inspection of the ferrous components without the need for additional handling or mechanics.

By possessing a pair of rotable discs that convey nonferrous components through inspection areas and a pair of nonrotable vacuum plenums that alternately hold and release the non-ferrous components, it is a further object of the invention to provide an automated inspection system that permits high speed dual-sided inspection of nonferrous components without the need for additional handling or mechanics.

It is a further object of the invention to provide an inspection system that is compact and requires less space than conveyor belt-type systems.

It is still a further object of the invention to provide an inspection system that is easier and less costly to operate and maintain.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a top view of an embodiment invention from the viewpoint of the noninspection side of the second rotable disc.

Figure 2 is a view of an embodiment of the invention used to inspect ferrous components from the view point of the noninspection side of the first rotable disc.

Figure 3 is a side view of an embodiment of the invention.

Figure 4 is a schematic depiction of a rotable disc according to the present invention.

Figure 5 is a depiction of one embodiment of a rejection assembly according to the present invention.

Figure 6 is a top view of an embodiment invention that inspects nonferrous components from the viewpoint of noninspection side of the second rotable disc.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The invention is an automated system for optically inspecting both sides of components manufactured at high speed for manufacturing defects.

Figures 1 through 3 show the preferred embodiment of the apparatus for inspecting ferrous components according to the present invention. The apparatus has a first drive system, which can be any conventional drive system, such as an electric motor, mechanical motor, or other type of motor or mechanical means and which is represented schematically in Figure 3 as **224.** The drive system has a shaft **227**. The shaft drivingly connects a first rotable disc **10** and a second rotable disc **50** to the drive or motor. A first nonrotable magnet **20** and a second non-rotable magnet **60** are positioned behind the rotable discs **10** and **50** (adjacent to the non-inspection-side faces of **10** and **50** which are **16** and **56** respectively) . First rotable disc **10** is rotatably mounted to the shaft **227** of first drive system **224**. In an embodiment, second rotable disc **50** is driven by a second shaft (not shown) of a first drive system **224**. Other alternating embodiments will include a second drive system **223** that drives the second rotable disc via a second shaft **226** as shown in Figure 3. However, it should be noted that any conventional means to drive the disks could be used. The rotable discs **10** and **50** are arranged so that inspection side faces **16** and **58** respectively are facing each other. As schematically depicted in Figure 4, in a preferred embodiment, each disc has an inspection area that coincides with an area near the perimeter of the disc. The inspection area is the shaded area in Figure 4. The invention

is not limited to having this particular area as the inspection area and contemplates that other areas on the disc may be the inspection area. The rotable discs **10** and **50** face each other and overlap. The point of overlap is depicted as dotted line **A** in Figure 3. The first rotable disc **10** rotates in a first direction **14** and the second rotable disc **50** rotates in a second direction **54**. A first nonrotable magnet **20** is positioned behind or adjacent to a noninspection side surface **18** of the first rotable disc **10**. A second nonrotable magnet **60** is positioned behind or adjacent to a noninspection side surface **56** of second rotable disc **50**. At a transfer station **90**, where the inspection area of the inspection side surface **58** of the second rotable disc **50** partially overlaps an inspection area of an inspection side surface **16** of the first rotable disc **10**, the components **100** are transferred from first rotable disc **10** to second rotable disc **50**. This can be achieved because first non-rotable magnet **20** exerts a lower magnetic force and second non-rotable magnet **60** exerts a higher magnetic force at transfer station **90**, or by way of an automatic mechanical device that is able to pick the components off of the first rotable disc and place them onto the second rotable disc. Figure 1 shows components on the inspection side surface **16** of the first rotable disc, while Figure 2 shows the components **100** on the inspection side surface **58** of the second rotable disc **50** after said components **100** have been transferred.

Returning to Figure 1, Figure 1 provides a view of the inspection side **16** of the first rotable disk **10**. A pair of infeed guards **120** is on the inspection side surface **16** of the first rotable disc **10**. A member of the pair of infeed guards **120** is positioned on each side of a first product infeed **110**. A first inspection assembly **30** is substantially adjacent to the first rotable disc **10**. The inspected components move along the first rotable disc in direction **14** to a first rejection area **40a**, which is adjacent to a first rejection assembly **40**. At this point, the components are moved off the disc if they do not meet certain inspection criteria. In a preferred embodiment, rejection is accomplished by the rejection assembly **40**. An exploded view of a rejection assembly is shown in Figure 5. The non-rejected components then move to a pair of transfer guards **130** on the inspection surface **16** of the first rotable disc **10**. A member of the pair of transfer guards **130** is positioned on each side of the transfer station **90**. At this point in the cycle, one side of the components has been inspected.

Figure 2 shows a view of the preferred embodiment of the apparatus and provides a view of the inspection side of the second rotable disk **50** on which the second sides of the components **100** are inspected after being transferred from first rotable disc **10**. A second pair of transfer

guards **170** is on a inspection side surface **58** of second rotable disc **50**. A member of the second pair of transfer guards **170** is positioned on each side of transfer station **90**. A second inspection assembly **70** is substantially adjacent to second rotable disc **50**. The inspected components move along the second rotable disc in direction **54** to a second rejection area **80a**, which is adjacent to a second rejection station **80**. At this point, the components are moved off of the disc if they do not meet certain inspection criteria. In a preferred embodiment, rejection is accomplished by the rejection assembly. An exploded view of such an assembly is shown in Figure 5, however, one skilled in the art will appreciate that other rejection devices, for example, an air jet, may be used. Optionally, a pair of exit guards **140** is on inspection side surface **58** of second rotable disc **50**. A member of the pair of transfer guards **140** is positioned on each side of a product exit station **146**. A first encoder **200** is on a bottom surface **18** of first rotable disc **10** and a second encoder **210** is on a bottom surface **58** of second rotable disc **50**.

Encoders **200** and **210** connected to the drives shafts **226** and **227** and optionally to the drives **223** and **224** and are used to determine disk rotational distance and speed. Once the component **100** is detected by an infeed sensor (not shown), the component **100** position is tracked. When the component is in the proper position under the inspection stations **30** and **70**, inspection data is acquired. Said inspection data can be in the form of an image, which can be acquired through electronic coupling. The data or image information is sent to a process computer (not shown) for analysis. Illumination light (not shown) is generated by a strobe lamp assembly, and directed onto the component **100** by the optical assembly (not shown). The component **100** continues around the disc **10** and **50** to the rejection areas, either **40a** or **80a**. If analysis of the picture image determines the closure is defective, then a reject signal is sent to the reject assembly **40** or **80** removing the defective components **100** from the respective rotable disc **10** and **50**. Acceptable components **100** continue around with the respective discs **10** and **50**.

Figure 6 shows the preferred embodiment for inspecting nonferrous components according to the present invention. The system works in all ways similar to that described above, except that instead of non-rotable magnets, a first **(not shown)** and a second nonrotable vacuum plenum **190** hold the components **100** in place, and the first and second rotable discs **10, 50** have a plurality of apertures **183**. The plurality of apertures **183** provide a means for first and second nonrotable vacuum plenums to hold nonferrous components **100** onto the inspection side surface **16** and **58** of first and second rotable discs **10** and **50.** Each nonrotable vacuum plenum is

positioned behind the respective rotable disc. At a transfer station **90**, inspection side surface **58** of second rotable disc **50** partially overlaps inspection side surface **16** of first rotable disc **10** in the manner depicted in Figure 3, and components **100** are transferred from first rotable disc **10** to second rotable disc **50** because first non-rotable vacuum plenum exerts a lower vacuum force and second non-rotable vacuum plenum exerts a higher vacuum force at transfer station **90**. All other aspects on this inspection system for nonferrous components are the same as that disclosed for the inspection of ferrous components.

While presently preferred embodiments of the invention have been shown and described, the invention may be otherwise within the scope of the appended claims.